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Terms and conditions of this supplement are considered to be the same as those in the basic contract.

Complete engineering information is contained in Enclosure 1, and Detailed Cost Analysis and Bill of Materials, Enclosure 2.

If further information is required, please contact the undersigned.

Very truly yours,

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PROPOSED DESIGN CHANGES

FOR

CHANGE DETECTOR

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SECTION I - INTRODUCTION

STATINTL [redacted] proposes to modify portions of the existing design of the change detector in order to increase its effectiveness as a screening and interpretation device and also to provide a greater film handling capability. The proposed modifications include the design and fabrication of new film magazines which will incorporate the following features: the capability of handling both perforated and unperforated 70-mm film; variable speed slewing of the film in two ranges, a slow slew for positioning of the film frames within the viewing aperture of the system and a fast slew for rapid movement of the film roll; frame counting and position reference indication for film frames of variable length; and a vertical aperture which enables the entire 70-mm dimension of the film to be viewed.

An orientation control which will permit the displayed images on the readout monitors to be rotated through a full 360 degrees is also proposed.

These modifications to the system design will require approximately three months for design and fabrication and one month for integration into the system console.

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SECTION II - TECHNICAL APPROACH

1. FILM HANDLING MECHANISM MODIFICATION

a. General

The present film magazines are designed to handle perforated film which is advanced on a frame-by-frame basis through the use of a geneva driven sprocket. A slow speed slew of approximately .15 in. per second is incorporated into the magazines by driving the sprocket through a differential from a velocity controlled vernier motor drive. The requirement of handling both perforated and unperforated film cannot be met using a sprocket type drive. The need for fast slewing of the film with velocities up to 24 inches per second cannot be met with the take-up speeds of the present spool drives. These requirements make necessary the design and fabrication of new film magazine assemblies.

A simplified block diagram of the proposed film handling mechanism is shown in Figure 1. The film will be driven by a capstan about which the film will be wrapped with a tension sufficient to ensure positive driving characteristics. The slow velocities used to position the film will be imparted to the film through the use of the capstan

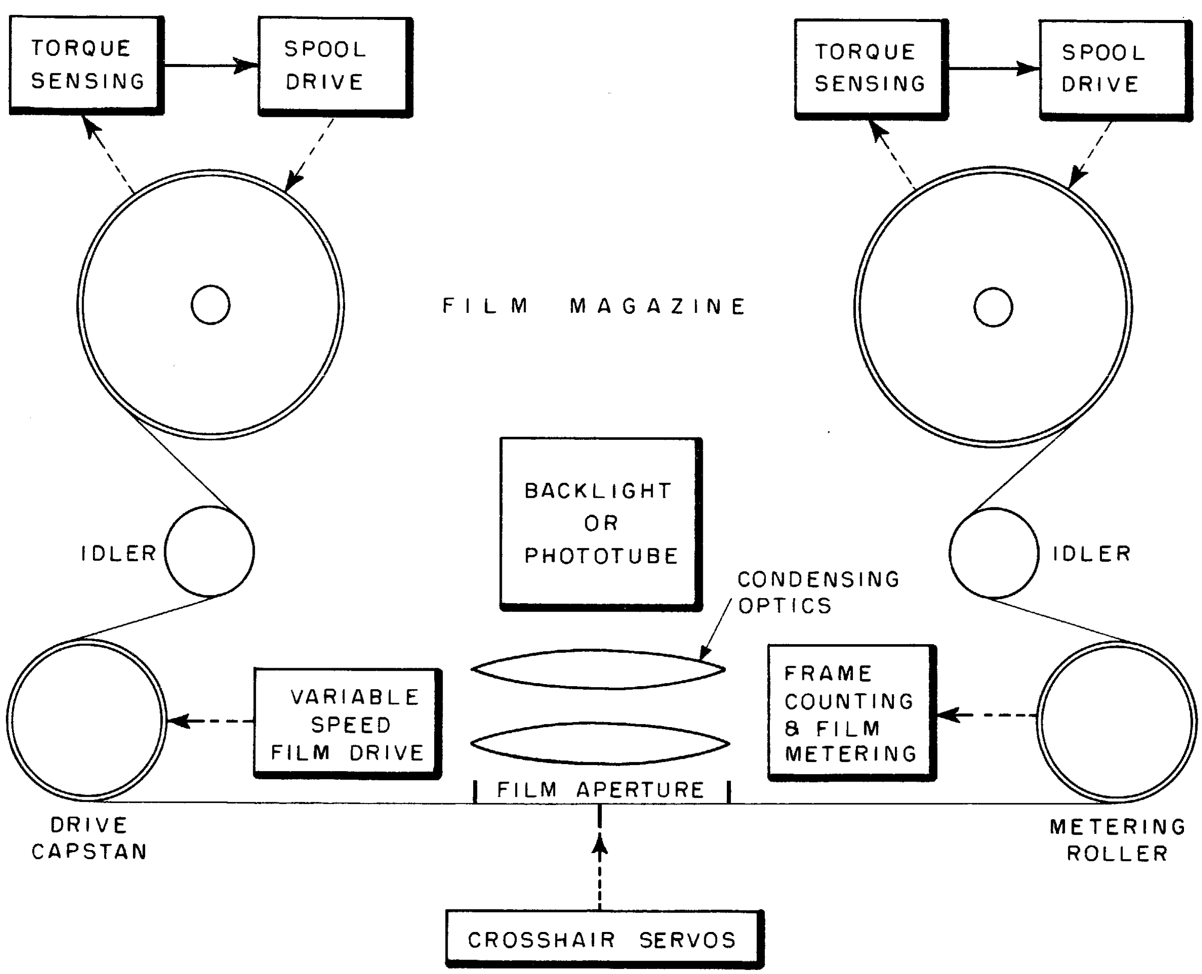

Figure 1 - Simplified Block Diagram of Film Handling Mechanism

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alone. High slew velocities will be accomplished by using the capstan drive and upsetting the tensioning torque of the film spools. The direction of slew will be reversible.

The film frame counting mechanism will be activated by a metering roller which is driven by the film motion. The film will be wrapped and tensioned about this roller to achieve negligible slippage. The roller will drive a pulsing device, such as an optisyn, from which digital counting circuitry will be attached to count film frames. Any number of different frame lengths can be counted by programming the digital counting circuitry to provide multiple outputs. The output of the counting circuitry will feed a pulsed indicator which will read directly in frames. The output of the optisyn will also be used to obtain positional information within a frame with respect to a reference or fiducial mark near the edge of the frame when the frame length is greater than that of the viewing aperture of the magazines.

The present cross-hair mechanisms are packaged closely with the present film drives. A redesign of the mechanisms for packaging will be necessary.

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The requirement to view material above and below the imagery on the film makes necessary a vertical enlargement of the apertures in the system to cover the full 70-mm vertical dimension of the film. The enlargement of the vertical apertures requires a modification to the film apertures, the film hold down mechanism, the condensing optics, and dove mirror aperture.

b. Variable Speed Film Drive

The implementation proposed for the variable speed film drive is illustrated in Figure 2. The film drive source will be a servo motor driven capstan. A tachometer integral with the motor will be used for feedback of velocity. Gearing between the servo motor and capstan will have two paths so that a ratio can be selected to match the velocity ranges desired. Using 10/1 as the range of velocities available from a fixed gear ratio with a velocity servo, the ranges will be 0.02 to 0.20 inches per second for the slow slew range and 2.4 to 24 inches per second for the high speed slew range. The velocities will be made continuously variable through each of these ranges from a front panel control potentiometer. The selection of velocity range can be made through the use of a duplex clutch

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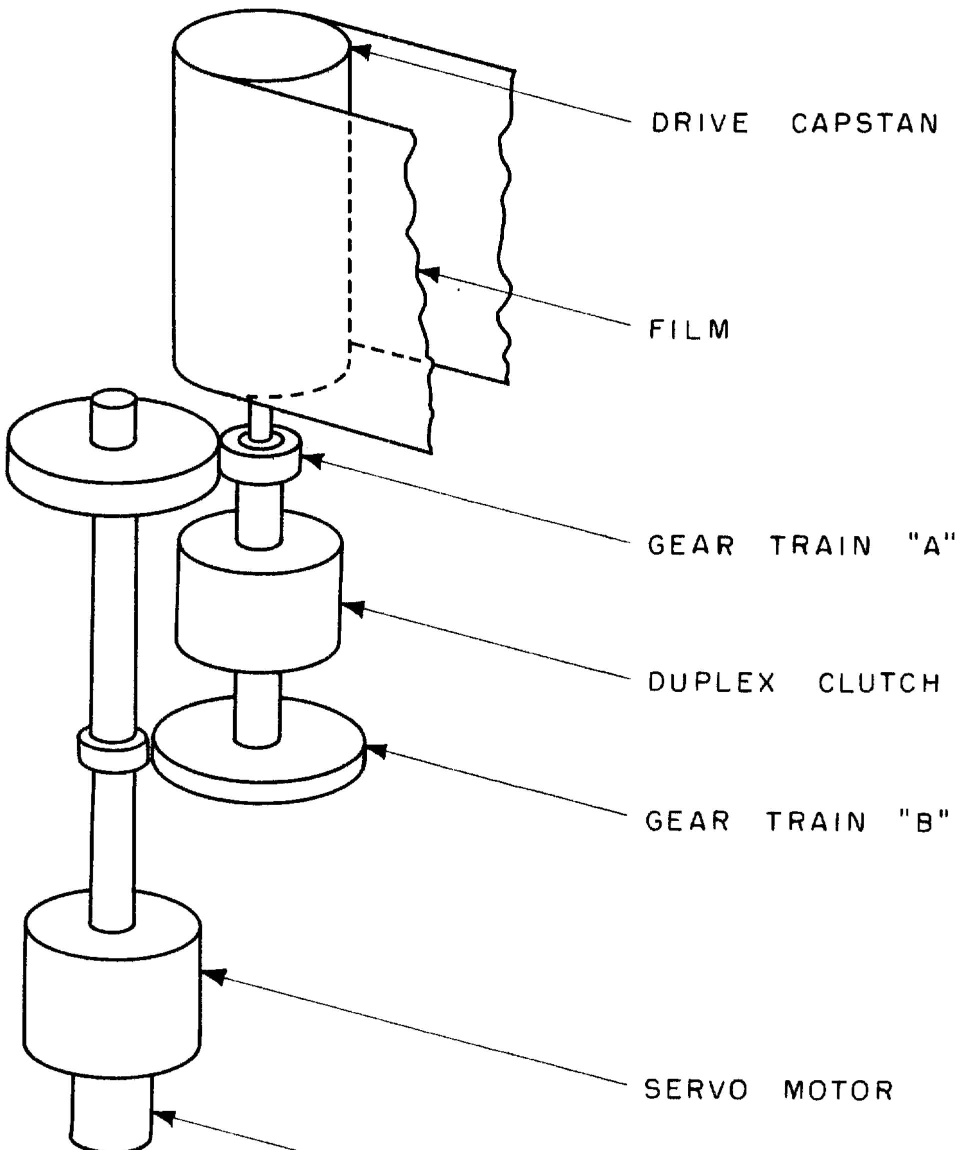

Figure 2 - Film Drive Implementation

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attached to the film drive capstan which is controlled from a front panel switch.

The film spool drive and tension control is shown in Figure 3. The film take-up and feed spools shall be torqued in such a manner as to maintain a constant tension on the film. The spools will be driven by a motor through a duplex clutch to select speeds and a magnetic particle clutch to control torque. Constant tension will be maintained by sensing the radius of wrapped film on the spool with a potentiometer and sensing roller arm. A functional potentiometer will be used which supplies an output voltage proportional to the torque required to maintain constant tension. This voltage will then be applied to the magnetic particle clutch whose torque is directly proportional to the voltage applied.

During the slow velocity driving periods the tension on the film will be maintained in a balanced state. During the fast slew mode of operation the torque in the magnetic clutches will be upset so that the spool expelling film will have no torque reflected to it from the motor. The tension on the capstan will be maintained by the inertial and frictional characteristics of the load. Accelerations

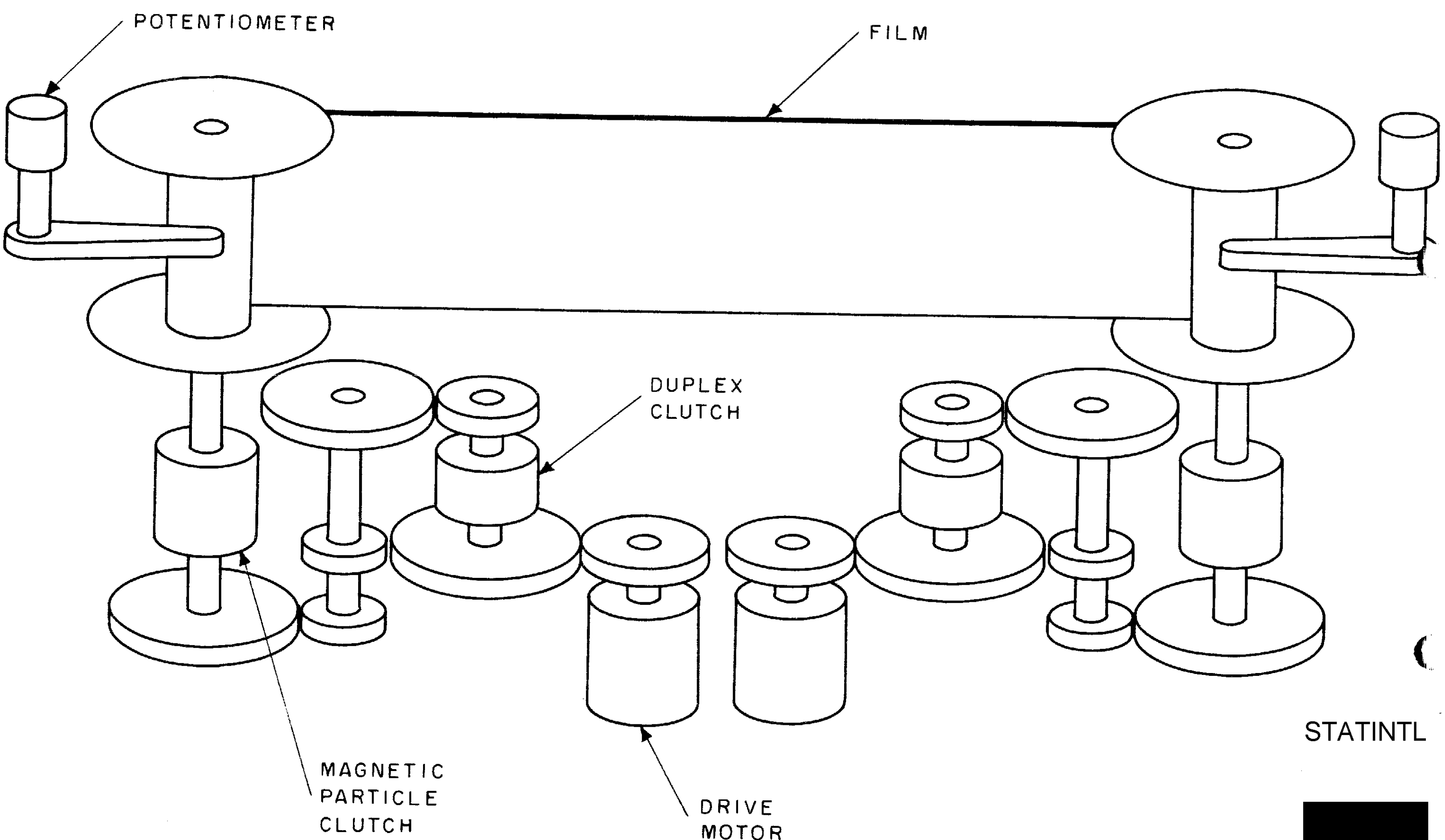

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Figure 3 - Film Spool Drive and Tension Control

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of the film speed will be limited to a value which will ensure that a sudden reversal of film speed control lever will not create a slack loop. This will be accomplished by using the tachometer output and controlling the torque time constant as a function of velocity.

c. <u>Film Frame Counter and Position Indicator</u>

The film frame counter shown in Figure 4 will derive information from a sensing roller which also serves as a guide roller for the film gate. The friction and inertia on this roller will be held to a minimum to reduce the possibility of film slippage between the roller and film. Attached directly to this sensing roller will be an optisyn type transducer. The optisyn is a very low inertia, low friction transducer which produces precisely spaced digital pulses as it is rotated. An optisyn which generates 400 pulses per revolution coupled to a roller approximately 1.27 inches in diameter will generate a pulse for each .01 inch or .25-mm of film travel. Digital circuitry will be coupled to the output of the optisyn and will count the number of pulses. When the count reaches the predetermined number for a given frame length, a pulse will be generated by the digital circuitry to advance a solenoid type read-

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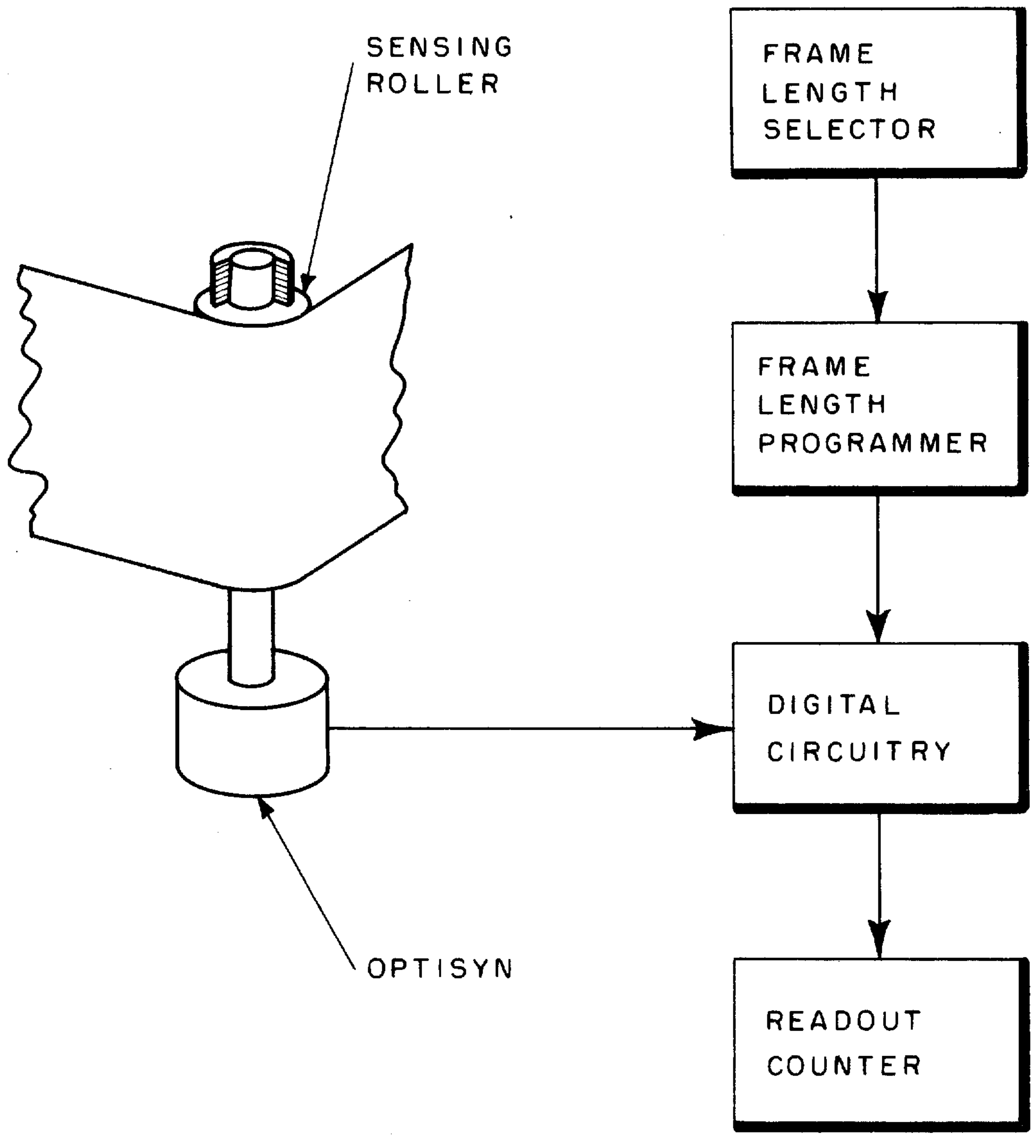

Figure 4 - Film Frame Counter

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out counter. The readout counter will read directly in frames and will have a manual zero reset. Utilizing a reversible readout counter, the counting circuitry will be designed such that a reversal in direction of the film will reverse the frame count. The digital counting circuitry will be designed to accommodate frame lengths from 2.25 inches up to 40 inches. The existing frame length requirements will be programmed into the circuitry which will be controlled from a front panel selector. Additional positions will be left on the frame length selector to meet future requirements for other frame lengths. Assuming a maximum error of .01 inch per frame, this method of frame counting will produce an error of less than 1 frame in a 250 foot roll of film when the frame length is greater than 5.5 inches. A 250 foot roll of film with 2.25 inch frame lengths will develop a maximum error of 5 frames at the end of the roll.

The output of the optisyn will also be used to provide a position reference for the cross-hair when the film frame length is longer than the film magazine aperture size. The output of the optisyn will feed digital circuitry which will count the pulses which occur each .25-mm of film travel.

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An output will be generated for every fourth input pulse which will represent 1-mm of film travel. A solenoid type readout counter, which will display an output in centimeters and tenths, will accept an output from the digital circuitry for each millimeter of film motion. The procedure for utilizing this readout counter in conjunction with the existing cross-hair position indicator will be as follows: with the cross-hair and cross-hair position indicator set to the zero position the slow speed film slew will be activated to align the cross-hair with the end of frame reference or fiducial mark. The reference position readout counter will be set to zero at this point. The film may then be slewed to place any desired area of the frame within the aperture of the system. The readout counter will read the distance that the film has moved from the reference point to the zero point of the cross-hair. When the cross-hair is moved within the aperture, the reading of the cross-hair position indicator can be added to the readout counter by the operator to obtain the position of the cross-hair with respect to the reference point. The utilization of a reversible type readout counter will permit the film to be slewed in either direction within a frame without affecting the position measure-

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ment once the reference position has been established.

d. Cross-Hair Position Mechanisms

The cross-hair position servo mechanisms will be implemented in the same manner as it is in the present design. The altered form factor of the film magazines, however, will make necessary a change in the form factor of the cross-hair assemblies to meet the packaging requirements of the new film magazines will be performed.

e. Vertical Aperture Increase

The requirement to view the entire 70-mm vertical dimension of the film makes necessary an enlargement of several of the vertical apertures in the system. The present film magazines have an aperture which is designed to cover a 2-1/4 inch by 2-1/4 inch area of the film. Increasing the vertical aperture to 2-3/4 inches (70-mm) will necessitate an increase in the size of the condensing optical system behind the film plane to obtain the required coverage. The method of holding the film within the aperture will be modified, since the present pressure plate utilizes the upper and lower edges of the film for this purpose. The use of a glass aperture and glass hold-down plate will be investigated for this purpose.

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The retaining bearing adjacent to the film plane in the dove mirror assembly also limits the size of the aperture in the present design. This end of the assembly must be modified to install a larger bearing and mount to achieve the required aperture.

In order to read the material above and below the imagery on the film, the maximum size of the scanning raster will be increased by approximately 20 percent.

2. IMAGE ORIENTATION CONTROL

a. General

Simultaneous orientation of the displayed images of the two films which allows the operator to observe the images from any angle can be best performed by a rotation of the scanning crt raster. A rotation introduced at this point in the system has no effect on the registration of the two images. Rotation of the deflection yoke is the most feasible method of obtaining raster orientation for the system. In order to permit rotation of the images displayed on the readout monitors about the center of the area being viewed, regardless of the position or amount of blow-up, all position information must be removed from the raster deflection yoke of the crt. Raster position signals for

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the selection of the areas of the films to be viewed will be supplied exclusively to the raster position yoke which will not rotate. A rotation of the area selection joystick assembly as the raster is rotated will provide the necessary orientation sense independent of rotation.

b. Raster Rotation

A rotation of the crt scanning raster about its center results in a rotation of the displayed images of the two films because the video generated by the scanning process is generated along the scanning lines of the raster. The orientation of the raster determines the angle at which the films are scanned by the raster. Since the rasters of the readout monitors remain fixed, the images displayed are oriented as a function of the scanning raster.

Several techniques for rotation of a raster are available. Feeding the vertical and horizontal raster deflection input signals into a synchro resolver is an approach which has been examined because it offers the advantage of simplicity. It has been discarded, however, due to the problem of passing the high frequency horizontal deflection signal with the fidelity that is required by the system. Rotation of the deflection yoke has been determined to be

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the most feasible method of obtaining image orientation.

The yoke must be rotated by a non-magnetic bearing material to avoid distortion of the magnetic fields necessary for deflection and focusing of the crt electron beam. A teflon bearing will provide this capability. The drive motor must be mounted outside of the magnetic shield which surrounds the crt to prevent its magnetic field from affecting the tube. A gearhead will be attached to the motor outside of the shield. A final gear pass made of non-magnetic material will enter through an opening in the shield to drive the gear mounted on the yoke. The rotation mechanism will be incorporated into a position servo loop with the control potentiometer located on the console control panel. The control potentiometer will be calibrated in degrees up to 360 degrees of rotation. Since continuous rotation beyond 360 degrees is not required, slip ring electrical connections for the rotating yoke are not required. Flexible wires will be adequate to meet the requirement.

c. Raster Position Modification

Rotation of the displayed images about the center of the viewing screens of the monitors regardless of the area of

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the film frame being observed requires rotation of the scanning crt raster about its center. Since the position and size of the scanning crt raster varies depending on the area being displayed, a translation of the raster as well as rotation would occur if either of the magnetic fields which position the raster were generated by the rotating yoke. The present design utilizes a separate yoke for horizontal position deflection, but the vertical position deflection is derived from the raster generation yoke. A special position yoke which will not rotate will be provided to generate both vertical and horizontal position information for the crt raster. Horizontal and vertical position amplifiers will accept inputs from the area selection joystick and supply the respective windings of the position yoke.

d. Joystick Orientation

In order to preserve the direction sense of the area selection joystick when the crt raster is rotated, the joystick assembly must also be rotated. This will be accomplished through the use of a position servo similar to that to be used to rotate the yoke. The position signal to control the angular displacement of the joystick assembly

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will be derived from a reference potentiometer located on the yoke orientation servo. As a result, the joystick assembly will follow the yoke as it is rotated to the desired position. The driving components for rotation of the joystick will be packaged as an integral part of the joystick assembly and will be located beneath the control panel.

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SECTION III - WORK STATEMENT

In order to perform the modifications to the existing system design which will meet the requirements of an increased film handling capability and an increased interpretation capability, the following tasks are proposed.

1. FILM HANDLING MECHANISMS

   Two new film magazine assemblies will be designed and fabricated which will accept perforated and unperforated 70-mm roll film; provide variable speed slewing of the film in two ranges, .02 to .2 inches per second and 2.4 to 24 inches per second; incorporate frame counting and position reference indication for film frames from 2-1/4 inches to 40 inches in length; and provide an aperture and condensing optics capable of displaying the full 70-mm vertical format of the films. The cross-hair servo mechanisms will be repackaged to be compatible with the film magazine form factors. Circuitry will be developed for the frame counting and position measurement functions.

2. DOVE MIRROR MODIFICATION

   The retaining bearing and other associated components of the dove mirror assembly which is adjacent to the film plane will be redesigned to meet the increased aperture requirement.

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3. ORIENTATION CONTROL

The scanning crt mount and associated deflection circuitry will be modified to incorporate a rotating yoke assembly which will permit 360 degree rotation of the displayed images on the readout monitors. Additional circuitry will be developed to provide position information to the crt. The area selection joystick assembly will be modified to provide a rotation capability.

Since the design of the present change detector equipment is nearly complete and the checkout phase has been initiated, it is recommended that the above tasks remain separate from the existing equipment until they are completed. Checkout of the remainder of the system with the existing film magazines, dove mirror assembly and crt assembly can continue while the new assemblies are being fabricated. Integration of the new assemblies upon completion will result in minimum of delay to the overall program.

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